robust, depressed, bifid spine; three front pairs of legs smooth; coxæ of hind legs terminating externally above in an obtuse, nearly perpendicular spinose projection; femora rugose, much curved, with a strong irregular spine projecting obliquely upwards from the upper surface of the distal extremity, a second shorter spine projecting laterally from the internal surface at end of first third; also a number of obtuse pectinate denticles projecting from each side, but radiating at the proximal extremity; tibiæ rugose, with three long curved spines and several minute denticles projecting downwards and inwards from inferior surface, a space being left between the first two spines and the third; tarsi simple; palpi subcylindrical, nearly smooth, with short slender spines; cheliceres cylindrical, pilose, the pincers serrated internally; ventral surface of cephalothorax dull, but smooth; last two segments of abdomen minutely granulated.

Length of cephalothorax $3\frac{1}{2}$ lines, of entire body, including closed cheliceres, 4 lines; relative length of legs 1, 3, 2, 4.

Chili (*Reed*). One specimen. B.M.

Possibly the *G. bicornis* of Nicolet, but without the double spine on the oculiferous tubercles, and with a different distribution of spines on the hind legs, so that I suspect it to be distinct; it is evidently allied to *G. modestus* of Nicolet.

Resemblances between the Bones of Typical living Reptiles and the Bones of other animals. By Harry Govier Seeley, F.L.S., F.G.S., Professor of Physical Geography in Bedford College, London.

[Read June 18, 1874.]

PART I.

THE SIMILITUDES OF CROCODILE BONES.

§ 1. *The Mammalian Characters of the Crocodile.*

In the palate, Crocodiles are remarkable for the extent to which the posterior nares are carried backward by the closing over them of the palatine and pterygoid bones. This condition is paralleled in the great toothless ant-eater, *Myrmecophaga*, where the nares are carried back behind the pterygoid bones so as to make a flat uncleft palate. Nor is the resemblance less close in the fore part of the skull; for the immense toothless maxillary

and small malar of the Ant-eater, essentially reproduce what obtains in the Crocodile, though the arch is entire in Crocodiles and the malar is not styloid : the nasal bones also conform to the Crocodilian type, and the premaxillary bones are relatively as small. From the absence of a transverse bone in mammals, there are no palatal pterygoid fossæ as in the Crocodile. But for the dicondyloid articulation, the back of the Ant-eater's skull is in many respects Avian.

The next nearest resemblance among mammals to the palate of the Crocodile is seen in the Cetacea, where the teeth are in some respects similar ; yet the Crocodile is peculiar in having the posterior nares entirely embraced by the pterygoid bones. And the Porpoises diverge far from Crocodiles in the backward position of the anterior nares, by which the premaxillary bones, owing to their relation with the extremity of the snout and the nares, come to be developed to a great length. The scarcely divided occipital condyle is made by the exoccipital bones in Dolphins, and not chiefly by the basioccipital bone as in Crocodiles.

Perhaps the nearest resemblance among mammals to the external form of frontal bone of the Crocodile, is seen among Rodents like the Rabbit, in which the orbits are relatively large and approximate closely. But in Crocodiles the bone does not close in the brain, and is undivided laterally, which is rarely the case with mammals.

In the vertebral column Crocodiles have but little in common with mammals and are distinguished from them by many characters. Their vertebræ are procœlian ; they have cervical ribs. Their dorsal ribs are attached by double heads to long transverse processes ; only one or two of the vertebræ between the neck and back have the lower head of the rib attached to the centrum. This condition is characteristic of the dorsal vertebræ in *Myrmecophaga*, while in the majority of mammals the rib articulates with two vertebræ. And it is only among Cetacea, especially the true Whales, that the dorsal ribs are supported on long transverse processes as among Crocodiles. But the ribs of true Whales differ alike from those of mammals, birds, and Crocodiles in having but one head for the rib as among Lizards &c. The caudal vertebræ retain the neural arch to the end of the tail, which is not the case with mammals. Some of the chevron bones have the two articular facets connected by a transverse

band, as figured by Wagler. This is also seen among certain of the Dinosauria, but not among mammals.

The dorsal rib of a Crocodile is divided on each side into four pieces, of which only the large proximal part is fully ossified. In most mammals the rib consists of two pieces, though a few (as some Dolphins) have one or more of the ribs consisting of three elements.

In Crocodiles the anterior part of the sternum widens, gives attachment to the pectoral girdle of bones, and is prolonged in front of them. In mammals the general aspect of the sternum is very like that of Crocodiles. The widening and forward prolongation of the anterior sternal part is quite equalled among true Whales (e. g. *Balænoptera*); and the Pig, Tapir, Rhinoceros, Lion, Seal, *Thylacinus*, for example, present anterior sternal elements similar in form to that of the Crocodile, but which are often compressed like the keel of the bird's sternum, and give attachment usually to the first pair of ribs instead of to the pectoral girdle; while the bones usually named coracoid and clavicle have but an uncertain existence in most mammals.

In the Crocodile the scapula unites with another bone usually named the coracoid, to form the glenoid cavity for the humerus to work in. In mammals the humerus usually articulates with the scapula only. In monotremes it articulates with scapula and coracoid; but then the coracoids uuderlap the episternum, and do not abut against the sternum as in Crocodiles. In the the Mole, among placental mammals, the humerus articulates with a scapula and coracoid, and, as in the Crocodile, that short strong bone abuts against the sternum.

In shape the coracoid bone in Crocodiles is very like the scapula, but differs from it in being perforated in front of the articulation. Its elongation precludes comparison with mammals; it is more like the bone in the *Echidna* than in the Mole. The scapula of the Crocodile, in its elongated flattened form, is not closely paralleled, the Mole and the Ox making the nearest approximations. It is wider from front to back at the humeral end than at the free end, and possesses a prearticular part, which are differences from mammals. In the small development and lateral position of the spine it resembles *Echidna*.

The humerus of the Crocodile differs from that of most mammals in not possessing a pit at the distal end for the olecranon-process of the ulna, and in having a crest at the proximal

end on the radial side of the bone. These conditions are reproduced in Bats, where the humerus is proportionally much longer. Many pachyderms, like the Horse, have a radial crest; and the Walrus, Seal, Sloth, &c. have no marked olecranon-pit. The head of the mammalian humerus is never so much compressed from side to side as in the Crocodile, and usually has a trochanteroid process in front of the articular surface, though this is wanting in Whales and in Man.

The radius of the Crocodile offers no striking modification of its own, and is chiefly distinguished from mammals by its straight and more cylindrical shaft, and freedom from ridges, which are but faintly developed even when present. In proportion and form the ulna of the Crocodile is best matched by the African Ostrich, and is sufficiently distinguished from most mammals by wanting the olecranon-process, which, however, is sometimes but little developed, as in the Sloth; but the mammalian ulna has not often the stoutness found in the Crocodile.

The carpus of the Crocodile is peculiar in consisting of a large and elongated scapho-lunar, a smaller elongated cuneiform, and a pisiform in the proximal row. Distally there is a small subquadrate bone under the cuneiform. If it represents the bone in the same position in Chelonians, then the bones usually developed as a distal row of carpals have no existence *. In the Grampus (*Delphinus orca*) the proximal row of carpals similarly consists of two bones; but they are not elongated, and there is no pisiform bone; similarly there is a very small distal carpal. But most mammals have two rows of many-sided carpal bones.

The form and proportions of the metacarpal bones and phalanges is very similar to that of clawed mammals. Mammals, however, usually have the proximal end of the bone flatter and the distal end more globular; sometimes (*e. g.* the Lion) the metacarpals have a similar tendency to overlap each other at the proximal end. In number of phalanges in the long fingers Crocodiles do not equal the Cetacea.

The pelvis of the Crocodile is peculiar in the exclusion of the pubis from the acetabular articulation of the femur. In the Horse, Llama, and many mammals an approximation to such an arrangement may be detected; and in *Myrmecophaga* the pubis

* See, however, Gegenbaur's 'Vergleichenden Anatomie,' erstes Heft, 1864, pl. 3.

is almost, if not entirely, excluded, though not in the same way as in the Crocodile. In many mammals the articulation is chiefly formed by ilium and ischium, as in *Echidna* and the Orang. In the Crocodile the ilium and ischium almost meet again in front of the articulation so as to form an acetabular foramen. As a whole the Crocodilian pelvis most closely resembles that of the Seals, though it meets the sacrum more nearly at a right angle. The ilium of the Seal differs from that of the Crocodile in being anchylosed to the ischium and pubis, in the oblique way (mammalian way) in which it meets the sacrum, and in not being prolonged so far either backward or forward. As among the mammals, the pubis is the slender bone, while the ischium is larger. But in mammals the ischium usually has an osseous union with the pubis along the median abdominal line, which condition does not obtain in Crocodiles. Speaking generally, there is considerable resemblance in form respectively between the pubis and ischium of mammals, such as the Orang, and the Crocodile, though the bones in the Crocodile are intermediate in length between those of the Orang and the Seal.

The hind-limb bones of Crocodiles, like the bones of the fore limb, are distinguished from those of many mammals by wanting epiphyses. The femur, like the humerus, is distinguished by the proximal end wanting the external trochanter so characteristic of mammals, which latter usually have the proximal articular surface more convex. The external trochanter which marks the middle of the shaft in many mammals, such as Pachyderms like the Rhinoceros, is also moderately developed in the Crocodile ; but there is no representative of the inner trochanter feebly developed in some mammals, such as Kangaroos, Tapir, Beaver, *Enhydra*, which is characteristic of the Dinosauria. The distal end is much more like the femur of mammals than is the proximal end, and may be compared to that of the Brown Bear, though in most mammals an antero-posterior thickening of the distal end constitutes a character which is not repeated in Crocodiles.

The Crocodile has no patella. The tibia is more cylindrical in its shaft than is the case with most mammals ; and the cnemial crest, which many mammals have in common with birds, is not developed. Among placental mammals the Porcupine has a tibia of similar form and proportion ; but its articular surfaces are better defined and somewhat different. A nearer resemblance is

found in the marsupial *Phascolarctos*, where the form of the articulations, especially the distal articulation, and the form and position of the muscular attachments offer a close parallel to the Crocodile; but the epiphyses and side-to-side compression of the bone serve to distinguish it. The fibula of the Crocodile is also nearly paralleled by *Phascolarctos*, which has the Crocodilian form of distal end, and comes much nearer to the Crocodile in form than does the fibula of the Porcupine.

The tarsus of the Crocodile approximates closely to the mammal type. The os calcis is quite like that of a mammal, only shorter and stronger; the astragalus is comparable with that of some of the Marsupials, though it does not make a close resemblance to any genus in form. The distal row of the tarsus is formed by two bones, a cuboid and a smaller naviculare; this portion of the Crocodile's tarsus is, perhaps, best compared with that of a Kangaroo, in which, however, the three cuneiforms, which in some shape characterize the tarsus of mammals, are small and developed between the thread-like metatarsals and the astragalus: these cuneiform bones are wanting in the Crocodile. Some mammals, like Ox and Deer, have but one cuneiform bone; and then the naviculare and cuboid are united.

The metatarsal bones have a general resemblance to those in clawed mammals. As in man, the inner (great) toe is the stoutest. The metatarsal of the fifth digit is only represented in the Crocodile by a claw-shaped stump. The claw-phalanges are more like those of marsupials than placental mammals; but the marsupials do not appear to have the lateral furrows which mark the bones in the Crocodile.

Crocodile bones frequently have at their terminal margins a striated or wrinkled aspect, which is not seen in mammals.

§ 2. *The Avian Characters of Crocodiles.*

The Alligator, in its divided nostril, comes nearer to birds than do Crocodiles; and struthious birds, like the *Apteryx*, in the forward extension of the nares approximate nearer to the Crocodile type than do other birds. The palatal osseous perforation under the nares of Crocodiles is present in birds, but is often elongated, and extends far backward. The posterior nares in many birds are anterior to the pterygoid-malar fossæ, and margined by the vomer, malar, and palatine bones. In these features,

as in some other parts of the skull, the Crocodile comes less near to birds than to mammals. A ligament extends from the postfrontal process to the malar bone in birds, and represents the osseous connexion between those bones which characterize Crocodiles and ruminant mammals. If a similar ligament united the distal end of the squamosal with the postfrontal in birds, it would enclose superior temporal fossæ, which in Crocodiles have osseous boundaries.

The lower jaw of the Crocodile is more like that of a bird than a mammal, being composite, perforated posteriorly, and having the articular element much developed on the inner side of the articulation, owing to the width of the articular end of the quadrate bone. In the Crocodile the bones are placed differently from the arrangement in birds, and the dentary rami remain separate. In view of some structures in fossil animals, it may be mentioned that in some birds the squamosal bone has a ligamentous, almost osseous, union with the quadrato-jugal.

The vertebral column in birds is in many respects unlike that of Crocodiles. Instead of the cup-shaped articular centrum, the bird has it merely concave from side to side, and never from above downward; while a few birds—Penguins—present the mammalian and chelonian type of having some vertebræ opisthocœlous. There are more vertebræ in the neck of birds than in that of Crocodiles, no bird being reported to have fewer than the Sparrow, in which Cuvier counted nine, and Prof. Owen twelve, while there may be twice that number; no bird has unanchylosed cervical ribs comparable to those of Crocodiles.

The dorsal vertebræ are fewer in number in birds than in the Crocodile; but the upper head of the rib is similarly supported on a transverse process, while the lower is uniformly attached to the centrum—an arrangement which only obtains in the Crocodile in the vertebræ which I name pectoral.

The sacral vertebræ of Crocodiles are unlike the sacrum of birds in never including more than two or three vertebræ which remain unanchylosed. In many birds the sacral elements similarly have transverse processes; but in Crocodiles they are separate bones, while in birds they are anchylosed with the centrums.

The caudal vertebræ of Crocodiles are much more numerous and much longer than in living birds. In birds the articular face of the centrum is usually flat or slightly concave in front and convex behind, while, where they exist, the anterior zygapophyses

look *downward* and the posterior zygapophyses look *upward*, and in every respect the posterior end of the vertebra has the characters which usually occur at the anterior end. To the majority of caudal vertebræ in Crocodiles hæmapophyses are developed; while scarcely an indication of such a structure is seen among birds.

The sternum of the Crocodile is unlike that of birds in form: it never has the keel which characterizes the majority of birds; and it never has the breadth and basin-form which characterize adult struthious birds. But similarly it gives attachment to several pairs of ribs and to the coracoid bones, which have a similar elongated compressed form, though they have not the synovial and close osseous connexion with the sternum which characterizes the Avian type, and are directed more outward.

In some birds, as the Penguin, a precoracoid portion of the coracoid bone grows down and encloses a coracoid foramen comparable to that of the Crocodile.

The scapula meets the coracoid at a similar angle to form the shoulder-joint in struthious birds and Crocodiles; and the bone has much the same general form in those birds that it has in Crocodiles, differing chiefly in being much narrower from side to side. The Crocodile scapula has not the tubercle which in birds and the lower mammals usually gives attachment to the clavicle. In birds with a carinate sternum the scapula meets the coracoid at about a right angle.

The humerus in Crocodile has about the same proportional stoutness and form which characterize Parrots. The proximal articulation is more convex in birds, where the head has a process on its ulnar side not seen in Crocodiles; the radial crest is similar in the two. At the distal end, in carinate birds, the condyles, especially on the radial side, are more developed; in this point the Crocodile is better paralleled by struthious birds like the Ostrich.

The ulna of the Crocodile is most nearly paralleled among birds in stoutness and form by the African Ostrich; but in the Ostrich the proximal end does not curve so much inwards towards the radius, nor is it so massive; the distal end is directed further inward.

The radius of the Crocodile is similarly comparable to that of the Ostrich, with a like difference at the distal end. The two

bones have much the same relative proportion to each other in the two groups of animals.

The long carpal bones of the Crocodile are not comparable to the short carpals of birds, which have the distal carpal row anchylosed to the metacarpus.

The five free metacarpal bones of the Crocodile are different from the three anchylosed metacarpals of birds; and the phalanges are very different, though in the Crocodile the three fingers most developed are those on the inner or radial side, which represent the digits of the bird.

The Crocodile's os innominatum is made up by elements comparable to those of birds, but differently proportioned. They remain unanchylosed with regard to each other, and are not anchylosed to the sacral vertebræ, as they usually are in birds, though they remain separate from the sacrum in the Penguin. In birds the ilia are always much more prolonged both anteriorly and posteriorly, and have the long axis of the bone identical with that of the sacrum, which is not the case in the Crocodile; in the bird the ilia approximate dorsally, in the Crocodile they approximate ventrally. The ischium and pubis are much more slender in birds than in Crocodiles, and less elongated; they are directed backward and are close together, while in Crocodiles the bones are rather directed forward, and expand considerably at their distal ends; and the pubis does not meet the ilium, but is supported on the anterior process of the ischium; hence in Crocodiles there is no obturator foramen. The articulation in the Crocodile's pelvis would be perforated as in birds, if the forward process of the ischium met the ilium, which it does not quite do. The bird in which these bones are best comparable to the Crocodile's is the Emu.

The femur in the Crocodile differs chiefly from that of the bird in the proximal end not being in the same plane with the distal end, owing to which, the bone has a twisted aspect. The proximal articulation in birds is not so globular, nor the end so massive; nor is the ridge, which looks outward and backward at the proximal end, so much developed. The bird is wanting in the powerful muscular attachments which make a sort of trochanter on the inner side of the upper half of the femur of the Crocodile. At the distal end the femur of the Crocodile resembles the bird's in having the outer condyle the larger; there is a similar small process on

the outer side; but the distal articulation is not so pulley-like, nor so deeply cut, in Crocodiles.

The tibia of the Crocodile is unlike that of the bird at both the proximal and distal ends. The proximal end in birds develops a considerable forward cnemial process; and at the distal end the Crocodile has no condyles like those of the bird.

At its proximal end the bird's fibula is usually very similar to that of the Crocodile, while it very rarely happens that the bird's fibula is prolonged to the distal end of the tibia (as in certain fowl), and then it is so attenuated that the shaft and distal end are not comparable to those of the Crocodile.

The tarsus of the Crocodile is in no way comparable with that of birds.

Even in the Penguin, where the bones usually named metatarsals are applied to the ground, they are still anchylosed together, and three in number, instead of four as in Crocodiles. The outside toe is the largest in birds and has most phalanges in the digit, while in Crocodiles the inside metacarpal is the stoutest, and has fewest phalanges.

The claw-phalanges are very similar in form in birds and Crocodiles; and a similar groove runs along each side of the bone.

Birds differ from Crocodiles in not having cervical ribs; the dorsal ribs of birds consist of only two pieces, both ossified, between the sternum and vertebræ, while in the Crocodile there are four elements, of which the proximal one only is fully ossified. The lateral ossifications of the bird's ribs are represented in Crocodiles by small cartilaginous processes. In birds the anterior head of the rib always articulates with the centrum, while in the true dorsal ribs of the Crocodile both heads articulate with the transverse process.

§ 3. *The Chameleon-characters of the Crocodile.*

The bones of the skull in the Chameleon are thin or represented by membranes, and thus are generally unlike the massive bones of the Crocodile; moreover the difference in size probably obscures some similitudes as well as some differences.

From the prolongation backward of the parietal and squamosals the skull has enormous perforations to represent the small temporal fossæ of the Crocodile. On the muscular mechanism which

produces this modification may be presumed to depend the high form of the head, the vertical quadrate bone, the absence of a quadrato-jugal (if it be absent), the lateral aspect and large size of the orbits and nares. The external nostril in *Chamæleon* is not enclosed by the premaxillary as in a Crocodile, but has that bone and the nasal dividing it, so that the nares look outward and are double. To bring the premaxillaries into harmony with the Crocodile's, it would be necessary to suppose that the Crocodilian bones had been turned round through nearly half a circle by having their anterior termination drawn backwards through the nares. This view would account for their narrowness in the dental border, the few premaxillary teeth (which do not exceed two, and those obliterated in old age), the divided nostril, &c.

The teeth, instead of being conical and in sockets, are flattened, serrated, and anchylosed with the jaw. Neither the maxillaries, palatines, nor pterygoids meet mesially on the palate, but are divided by a groove. The middle holes of the skull, covered by membrane, are large, between the orbits and nares, look upward, and are divided by the premaxillary and frontal bones; in living Crocodiles these perforations have no representative. The occipital condyle is chiefly made by the exoccipital bones, which meet mesially, as in Chelonians; in Crocodiles the condyle is chiefly made by the basioccipital. In the Chameleon the lower jaw does not extend backward behind the articulation with the quadrate bone.

Throughout the vertebral column there runs a transverse platform, which is made by the zygapophyses extending outward, beyond and above the small flat single facet on the lower part of the side of the centrum to which the rib is attached; in Crocodiles the wide platform is made by the transverse process which carries the rib.

The cervical vertebræ are short from front to back, and have a hypapophysis. The last two of the five have long ribs, which are free at their distal ends. The dorsal vertebræ have the centrum somewhat elongated; and the neural arch is long, especially in the early part of the back. All the vertebræ, except the last two, appear to have ribs, which, relatively are enormously long, cylindrical, and in the dry state only consist of a dorsal and sternal part, though in a fresh specimen the latter joints into four parts. In the tail, though transverse processes are developed, they are directed downward and outward from the hinder corners

of the centrum. After the first three vertebræ a hypapophysis is developed, and the neural spine becomes short, and stands between the posterior zygapophyses. So that the vertebral column has little in common with the Crocodile's beyond a short neck, a long tail, a sacrum of two vertebræ, and a procœlous centrum. The transverse processes in the tail of the Crocodile are directed outward and not downward, and the zygapophysial facets in the tail of Crocodiles look upward and not inward. In the Chameleon the neural spines are relatively small, and the chevron bones are small and short.

The principal part of the sternum has its lateral portions inclined to each other like the sides of a boat. The anterior pair of the four sides (which make it diamond-shaped) give attachment to the coracoids; and there is no episternal part prolonged between those bones and anterior to them, as in a Crocodile. Only one pair of sternal ribs are attached to the first part of the sternum, two pairs to the second part, and one pair to the third part. These characters, with the keel running down the sternum, are the chief differences of this region from that of the Crocodile.

The scapular arch similarly consists of scapula and coracoid; but the bones are not inclined to each other at the great angle observable in the Crocodile.

The coracoid is a compressed subquadrate bone, with the anterior margin convex, and a posterior margin made by two concavities, of which the superior one is completed above by the scapula, and so forms the articulation for the humerus, which, instead of looking outward and backward as in the Crocodile, looks directly backward. The bone only resembles that of the Crocodile in being similarly perforate in front of the articulation. The scapula differs from that of the Crocodile more in proportion than in plan, being twice as long as the coracoid; for the part of the bone which in a Crocodile is thin, flattened, and expanded, is here prolonged with the ribs as a flattened cylindrical bone, slightly widening as it becomes more compressed towards the free end. The Chameleon has no spine to the scapula like that in the Crocodile.

The humerus in the Chameleon is relatively longer, straiter, more slender in the shaft, and more massive at the proximal and distal ends; the radial crest is more massive than in the Crocodile. The distal end has two well-marked condyles, of which the outer one is hemispherical; immediately above the condyle is a depression in which a large vessel enters the bone. These features are

unlike those of the Crocodile, and approximate to those of clavicular Lizards.

The ulna and radius are relatively longer than in the Crocodile. The ulna is a straight cylindrical bone enlarging at the proximal end on the anterior and outer sides; the subquadrate articulation has two oblique facets, one looking upward and forward, the other upward and outward toward the radius. The distal end in the Crocodile is relatively smaller, and has not the same convex lizard-like articulation. The proximal end of the radius is subcircular and cupped; the distal articulation appears to be obliquely truncated and to look backward.

The carpal bones have nothing in common.

The metacarpals of Chameleon are short broad bones, not unlike in form to the proximal carpals of Crocodile. The phalanges of Chameleon are all of great length and strength, and so far unlike the short small phalanges of the Crocodile. The digits of the Crocodile are arranged in a group of three, in which their metacarpal bones overlap each other proximally, and have no distal carpal ossified, and a group of two smaller outer digits articulated to one distal carpal bone. If we suppose the proximal ends of the metacarpals of the Crocodile to enlarge so as to thrust these groups away from each other, an arrangement might be produced like the hand of the Chameleon.

The pelvis of the Chameleon is unlike that of Crocodiles. The ilium is an elongated compressed narrow bone, shorter than the scapula, and more expanded at the free end; it descends from the transverse processes of two vertebræ almost vertically, but slightly forward, in a straight line with the os pubis, than which it is slightly wider from back to front. The pubis is a short straight bone almost equally expanded at both ends, entering into the acetabulum for the femur and perforated in its upper third for the obturator nerve, like the pubic bone in Lizards. The pubes are inclined to each other, and meet along the whole ventral margin of the bone, which is not the case in Crocodiles. The ischium is more like that of a Crocodile in outline, differing in wanting the process which gives attachment to the pubis, and in being longer from back to front, chiefly owing to the development forward of the anterior distal angles.

The Chameleon femur is about as long as the humerus, and similarly has a straight cylindrical shaft more enlarged at the distal and proximal ends than is the case with Crocodiles. The

proximal articulation is more nearly hemispherical, and has the inner side of the head more developed. In front is a transverse and vertical triradiate notch for the ligamentum teres; behind, the proximal end of the shaft is compressed. The bone terminates distally in a well-rounded trochlear articulation, above which, on the posterior aspect, is a deep depression.

The tibia and fibula are shorter than the femur—the tibia straight, but the fibula curved like an ulna upside down. The tibia is massive at the proximal end, with a transverse concave articulation adapted to the femur; its distal end is subcylindrical and obliquely truncated. The fibula is compressed behind; and a sharp ridge runs posteriorly down its length.

The tarsals are entirely different.

The metatarsals are short, like the metacarpals, the elongation of the foot being made by the phalanges; there is nothing analogous to the arrangement of the digits in the Crocodilian hind foot to be seen in the Chameleon.

§ 4. *The Lacertian Characters of Crocodiles.*

Iguana is like the Alligator in having the nostril double, but unlike that animal in having its outer margin made by the maxillary bone, and its inner division by a single premaxillary. The frontal and parietal are similarly single; and the bones generally correspond in their connexions; only a small quadrato-jugal appears to be placed in front of the squamosal at the proximal end of the quadrate bone, so that the malar arch is not prolonged, as in the Crocodile, to the distal end of the os quadratum. And the temporal fossæ, which are small in Crocodiles, are here so enormously enlarged that they prolong outward and backward, in a V-shape, diverging processes of the parietal bone. The high position of the quadrato-jugal would seem attributable to the great development of the postfrontal in making the outer margin of the temporal fossa.

There is nothing in common in the arrangement of the bones on the palate, owing seemingly to the elevated shape of the Lizard's head, by which the maxillaries are withdrawn from the palate and the palatine bones go forward to take their places.

The lower jaw in the Lizard is not perforated behind like that of the Crocodile; it has the articular bone developed inward to even a greater extent than in Crocodiles, and has the coronoid

developed into a strong erect process, of which there is no trace in the Crocodile.

It is probably due to the vertical position of the maxillary bone that the teeth of Lizards are not in sockets, the inner alveolar border being drawn away from them in the elevation of the bone from a horizontal to a vertical position. The teeth of Crocodiles differ but little from front to back; but in the *Draco volans* there are kinds which might represent incisors, canines, and molars; and in many Lizards the premaxillary teeth are sharper, or of different form from the others, and the hinder maxillary teeth undergo a change in the form of the crown quite analogous to what is seen in mammals.

The fewer neck-vertebræ of Lizards are not usually furnished with ribs; and when, as in the Skink, ribs are attached to all the vertebræ except the first two, they have only one articular head. The centrum never has the cylindrical form seen in the Crocodile; and the dorsal vertebræ never have transverse processes, except in the first few vertebræ of the Dragon, which give off the first ribs to the parachute, where in form they are very unlike those of the Crocodile. The dorsal vertebræ rarely have the vertical, flat, oblong neural spines of the Crocodile; the neural spines are suppressed in the Dragon, small in the Skink, compressed in front, and oblique in *Iguana*. In the Monitor, however, the neural spine is very like the Crocodile's throughout the vertebral column. The cup-and-ball articular vertebral surfaces are usually transversely depressed and oblique, which is not the case with the Crocodile's.

Between the dorsal vertebræ which are united with the sternum, and the neck, are the ribs (with massive ovate heads slightly concave at the articulation) which assist in supporting the shoulder-girdle. The dorsal ribs never include more than three ossified parts, though in *Iguana* a short unossified cartilage intervenes between the middle and sternal elements, assimilating the rib to that of a Crocodile.

The caudal vertebræ of *Monitor*, though far more numerous, are very similar in form to those of the Crocodile, differing chiefly in the centrum having a cup-and-ball articulation and in its obliquity. In Skinks the neural spine is suppressed; and in Dragons the vertebra is elongated, and its processes scarcely noticeable.

The sacrum similarly consists of two vertebræ.

The pectoral arch includes, besides the elements met with in

Crocodiles, a T-shaped or +-shaped episternum, and clavicles. The coracoid is more like the Chameleon's than the Crocodile's in form, but differs from both in its anterior emargination and processes directed towards the episternum. The scapula is most like that of the Dragon. *Stellio* and *Polychrus* approximate in having the bone narrow; but in most Lizards the bone has an expanded and emarginate form, or even unites along its anterior side with the coracoid.

The humerus is broader at both ends than a Crocodile's. The radial process is thick and blunt, and does not make an angle with the upper surface of the bone, as it does in Chameleon and Crocodile, though in the limbs the Chameleon is less closely approached by the adult Alligator than by the young animal.

The distal end of the humerus in Lizards has three condyles, of which the middle one is usually most developed. The humerus of the Dragon seems more like the Chameleon's than the Crocodile's, but has the radial crest smaller.

The ulna resembles the Crocodile's in being compressed from side to side, though it is even more compressed; but it differs in the development of an oblique olecranon ossicle, which gives to the bone a testudinate form. The distal end is expanded, with the articulation subhemispherical and convex from side to side as in the Chameleon, and not convex from front to back as in the Crocodile. The ulna is not so long as the humerus; but, owing to the development of the olecranon, the disproportion is not usually so marked as in the Crocodile. In the Skink the proportion of the forearm is most Crocodilian.

The radius is a not dissimilar bone to that of the Crocodile; only in Crocodile the proximal end is concave, and the part of the distal articulation which is most prolonged becomes a prominent boss.

The carpal bones are not conformable.

The metacarpals and phalanges are not dissimilar, and differ chiefly in Lizards having the claw-phalanges compressed from side to side.

The pelvis of Lizards is very uniform, and, both in its entirety and in the forms of the constituent bones, is very unlike that of the Crocodile. The pubis, like the coracoid, is usually perforated; it enters into the acetabulum for the femur, and develops a prepubic process. The posterior end of the ilium is more prolonged backward, and the anterior ventral angle of

the ischium more prolonged forward, than is the case with Crocodiles.

In *Monitor* the femur is straighter than in Crocodiles; and behind the proximal articulation the bone is compressed, and terminates in a strong inner trochanter, of which condition there is hardly a trace in Crocodiles. The distal ends are similar; but the fibula articulates with the outer side of the distal end in Lizards.

The tibia and fibula are not unlike those bones in Crocodiles, except that the Lizard fibula is somewhat compressed, so as to have a ridge down each side; and the tibia, instead of being subquadrate at its distal end, is compressed from back to front, and more expanded from side to side.

The proximal row of tarsal bones is usually anchylosed together; and the part corresponding to the heel of the os calcis is much less developed than in a Crocodile. The distal row seems to similarly consist of one or two small bones.

Except that the phalanges of the fifth digit are suppressed, the arrangement of the other bones of the hind foot is similar in the two. In Lizards the proportions of the bones are different, the fourth metacarpal being the longest and strongest; the claw-phalanges are similarly compressed from side to side. The bones of Lizards and Chameleons are much thinner than those of Crocodiles; and all the limb-bones differ from those of Crocodiles in having epiphyses.

The Blindworms have no special resemblance to Crocodiles. Their ribs throw off a tubercle just behind the articular head, which looks as though it might foreshadow double-headed ribs; but the process has no attachment. Between the dorsal vertebræ which bear ribs, and the caudal vertebræ with anchylosed chevron bones, are two or three sacral vertebræ, which have the transverse processes specially modified, sometimes double, as in *Python*, but in no respect like the Crocodile's.

§ 5. *On the Rhynchocephalian Characters of Crocodiles.*

Hatteria resembles Crocodiles in having the quadrate bone firmly wedged in the skull, but differs in the relations of the bone; for although a malar arch extends from the maxillary to the base of the quadrate, as in Crocodiles, the quadrato-jugal bone does not intervene between the quadrate and the malar. The quadrate, too, is nearly vertical, and sends a long straight wing inward overlapping the pterygoid in front, much after the manner of the

Dinosaur *Scelidosaurus*. The palate, though flat and closed, as in Crocodiles, would seem rather to be constructed after the plan of *Chamæleon* and of those Emydian Chelonians from which that plan is modified; for the pterygoids, according to Dr. Günther, entirely divide the palatine bones extending between them to meet the vomera, with which they form the middle of the osseous palate; in Crocodile they only advance a little way between the palatines, and the vomer does not come into the palate.

The parietals diverge behind as in Lizards; and the diverging processes are overlapped by the squamosal. Yet parietal, frontal, nasal, and premaxillary are all double; and between the parietal and frontal is a foramen parietale.

The vertebral column (since the vertebræ are biconcave, devoid of transverse processes in the back, with oblique neural spines and, in the caudal region, with small chevron bones) has little in common with the Crocodile's. Still the articulation of the centrum is vertical; the first three vertebræ in the neck have no ribs; the fourth has a double head, but rather after the plan of *Pliosaurus* than of *Crocodilus*. The dorsal ribs have epipleura which in the early vertebræ are cartilaginous as in Crocodiles, and the middle ones ossified as in birds, but remaining unanchylosed as Dr. Günther found them to be in the mature egg of the Pheasant. The sternal and hæmal ribs are very unlike the Crocodile's. The caudal vertebræ divide into anterior and posterior parts, as in Lizards.

The sternum, episternum, and clavicles are after the plan of Lizards'. The perforated coracoid more nearly resembles that of the Chameleon, while the flattened ossified portion of the scapula, which has a slight spine, is in the main Crocodilian.

The pelvis is about intermediate between *Chamæleon* and *Testudo*, and in no respect Crocodilian. The limbs are essentially Lacertian.

§ 6. *The Chelonian Characters of Crocodiles.*

In Chelonians the quadrate bone is wedged into the skull much as in Crocodiles, though it is usually vertical, with a tendency to incline forward rather than backward. It is similarly united to the malar by a squamous quadrato-jugal, though in the Testudine family, owing to enormous excavation of the quadrate and squamosal bones, the squamosal has a tendency to retreat up the side of the quadrate after the plan of Lizards. The malar bone in

both types similarly forms the back of the orbit; but in Chelonians it does not similarly exclude the maxillary bone from entering into the orbital circle, seemingly owing to the large size and forward position of the eyes. And for this reason, though the nostril is single as in Crocodile, it is surrounded by the premaxillary, maxillary, and prefronto-nasal bones. The upper surface of the Chelonian skull is very unlike that of the Crocodile, owing to the serpent-like and Chameleonoid prolongation backward of the parietal and supraoccipital bones, the enormous temporal fossæ, the double parietal and frontal bones, the general absence of distinct prefrontal and lachrymal bones, and the vertical Lacertian position of the maxillary. The palate is similarly closed in the median line; but the nostrils are not carried back in a tube, the Testudine arrangement in this respect reminding us as much of Chameleon as of Crocodile. And the palatal resemblance is not so close as it seems at first sight to be, since, from the presence of a transverse bone and downward prolongation of the pterygoid bone to meet it, the lateral palatal vacuity of the Crocodile is of a different nature from that of the Tortoise. In the vertebral column there is scarcely any thing in common. In the tail only of Emysaura (*Chelydra serpentina*) there is a superficial resemblance to Crocodiles, the centrum being elongated and compressed, having transverse processes, a vertical articulation, and chevron bones; but the articulation is opisthocœlous, and the neural spine is suppressed.

The scapula and coracoid in both groups are the only bones in the pectoral arch. But the Chelonian scapula is a cylindrical rod; and though in the Emydian and Testudine families the coracoids have a sub-Crocodilian expansion of their distal ends, they do not articulate with the sternum as in Crocodiles, or even with each other.

The Chelonian humerus is the stronger. Its radial process is like that of the Crocodile, but is prolonged nearer to the hemispherical articular head; while on the other side a strong ulnar process is prolonged beyond the articulation, and to this the Crocodile has nothing analogous.

The compressed ulna of clawed Chelonians is unlike the bone in Crocodiles. The radius is better comparable; but in Chelonians it never has so cylindrical a shaft, and the distal end has a more simple articular surface.

The carpal bones are not comparable. The metacarpals and

phalanges in Emydians are not dissimllar; only with them all the digits terminate in claws, and the metacarpal bone of the fifth finger is the stoutest.

There is very little in common in the pelvis, which in Chelonians is more like Lizards' than Crocodiles'.

The femur is a stronger bone in Chelonians, with a large hemispherical instead of a compressed subovate articular head. It might be considered to diverge from the Crocodile's more than Lizards', since the trochanteroid ridge which is developed behind the head of the bone in Lizards may here be regarded as greatly expanded from side to side, so as to produce an enormous trochanter; and to this modification the Crocodile offers no analogy.

The tibia and fibula have a general resemblance, except that in Chelonians they are stouter, and differ a little in their distal articulations.

The os calcis and astragalus of Testudines are anchylosed together, and show nothing like the Crocodilian form. The distal row of bones is more numerous than in Crocodiles.

In reducing the digits of the hind foot to four, *Testudo* becomes Crocodilian; and, as in Crocodiles, the hind foot is more elongated than the fore foot, though not to the same extent.

§ 7. *The Ophidian Characters of Crocodiles.*

The resemblances of Serpents to Crocodiles are necessarily limited to the skull and vertebral column. Like Alligators, serpents have the nostril divided by the nasal and premaxillary bones; but the premaxillary is single and toothless. Almost every other character gives matter for distinction; in the poisonous group the divergence is least, from both frontal and parietal bones being single.

In the vertebral column the resemblance is limited to the procœlous articulation of the centrum and the compressed subquadrate neural spine.

§ 8. *The Urodelan Characters of Crocodiles.*

No skull of a living Amphibian is likely to be mistaken for that of a Crocodile. The nasal sac is surrounded by premaxillary, maxillary, nasal, and vomerine bones. As in *Monitor*, neither orbit nor orbital fossa is circumscribed by bone. As in fishes, an enormous parasphenoid covers much of the base of the

skull, and it divides the pterygoid from the palatine bones. The nares do not open upon the palate.

The dorsal and caudal vertebræ of the Menopome resemble the Crocodile's in having the ribs supported on transverse processes; and in some types the articulation of the rib's head is divided. The ribs never encircle the viscera; and there are never neural spines. In the tail the chevron bones are anchylosed to the centrum. The centrum appears to be biconcave.

The scapula is very like that of the Crocodile, but widens at the acetabulum for the humerus, so as to become ⊥-shaped. In the Menopome epiphyses to the limb-bones are not ossified.

The humerus is twisted, and expands widely at the distal end. At the proximal end the radial crest is greatly developed, but, from the twist in the bone, does not make an angle with the shaft.

The ulna and radius, though stouter in the Menopome, have sufficient resemblance to make a detailed comparison necessary with both Crocodilia and Testudinata.

The carpus in the Menopome is unossified, and so far resembles the condition of the Crocodilian distal carpal series, though in other Urodelans all the elements are changed to bone. The metacarpals and phalanges are compressed from above downward, like those of some Dolphins.

In the pelvis there is no near resemblance; and the hind limbs are formed more on the Lacertian than on the Crocodilian plan.

PART II.

THE SIMILITUDES OF CHELONIAN BONES.

§ 1. *The Mammalian Characters of Chelonians.*

There is in Chelonians a nearer resemblance than in Crocodiles to the usual plan of the mammalian posterior nares, since they are divided by the vomer, and have their anterior lateral border made by the palatine. And in mammals the anterior nares are similarly single at their termination, except in the Por-

poises and Armadillo. Except, however, with the Porpoises and Man, a mammal rarely admits the maxillary bone into the border of the anterior nares, as do Chelonians.

Except in certain Rodents, some Monkeys, and Man, those mammals which have the orbit for the eye surrounded with bones do not admit the maxillary bone into its border, as is usual with Chelonians. The lateral eyes and terminal nostril are mammalian; but only in Man are the similarly placed premaxillaries so small.

Certain Carnivora have the parietal and supraoccipital bones elevated into a median crest, but it is never prolonged so far backward as among Chelonia.

The essential difference between the mode of union of the skull with the vertebral column is made by the forward recession among mammals of the basioccipital element.

The forms of Chelonian ribless cervical vertebræ may be paralleled in mammals. The testudinate group has its analogues in such long-necked forms as the Giraffe and Llama. The marine group has more the proportion of the neck-vertebræ in the Sheep; but there is a stronger hypapophysis, and only an indication of the transverse process characteristic of short-necked mammals. The opisthocœlous feature of the earlier vertebræ is a character of ruminant mammals.

The dorsal ribs have a mammalian character in articulating between the bodies of two vertebræ, though they usually differ in appearing to have no union with the neural arch. When, as with the Armadillo, a mammal is covered with an osseous sheath, it is not homologous with that of Chelonians, being merely dermal, and having no osseous union with the skeleton.

The tail in the marine and testudinate groups agrees with most mammals in wanting the chevron bones; but all Chelonians differ from mammals in having the neural arch prolonged to the end of the tail.

The pectoral arches are dissimilar.

The curves in the mammalian humerus appear at first sight to be the reverse of those in the Testudinata, owing to the bone being directed forward instead of backward, so that the left humerus of one type resembles the right humerus of the other. The bone corresponds most closely in form with that of Seals, which in common with many Carnivora, have a similar hemispherical head and a similar foramen on the inner and lower border of the shaft,

though in Chelonians it is usually a groove. And some mammals, like the Walrus, have a trochanteroid ulnar process prolonged beyond the articulation, after the manner of Chelonians. The distal end of the bone is not more thickened than in those mammals which show least trace of an olecranon-pit.

The mammalian ulna—which is usually behind the radius, and when external to it, as in Carnivora, is external only at the distal end—reminds one of the testudinates in the way in which the bone is compressed from side to side. The young Elephant is comparable to the old Tortoise in the extent to which the olecranon process of the ulna is developed. But the best parallel to the bone as a whole is seen in the *Manatus australis*, if we neglect the combined distal epiphyses, on which both ulna and radius abut. After the plan of the Beaver, the radius is the smaller bone of the two. Perhaps its nearest general resemblance in form is to the Manatee, where, however, the bone is relatively stouter, and is suturally united to the ulna at the proximal end: at the distal ends the bones similarly touch each other on the inner side.

The carpus in its two rows reproduces all the elements usually found in the mammal; and in the Testudines the scaphoid and lunar bones are usually anchylosed as in some Carnivores.

The metacarpal bones are shorter than in any mammal; the phalanges are as short as those of the Rhinoceros; and the terminal claws resemble those of marsupials in wanting the lateral groove, but differ in being depressed.

The pelvis is entirly mammalian in the forms and grouping of the bones. The ilium is an elongated massive bone rather less expanded antero-posteriorly at the sacral end than in the Tiger. It contributes, with the pubis and ischium, to form an imperforate acetabulum for the femur, as in mammals; and its articular surface similarly looks downward. The bone differs from the ilium of mammals in being directed according to the reptilian plan, upward and backward from the acetabulum, instead of forward; in the Testudines its direction is more vertical than in the Chelonian type. And it differs from mammals' in not having the sacral end produced beyond the bones with which it articulates.

The pubes and ischia meet mesially in *Testudo* as in mammals, so as to enclose two large obturator foramina. The ischia are massive behind, transversely truncated, and directed a little downward, with an angular process behind, after the

plan seen in the Elephant. The pubis is proportionally larger than in any mammal, the expanded flattened bones of Chelonians differing in having a mesial angular prolongation forward, of which there is a faint indication in the Camel, but which, if transversely truncated and ossified separately, would have made prepubic bones after the pattern of those seen in the Monotremes. External to this is a strong digit-like process directed outward, of which only a faint trace is seen in *Echidna*. In the marine Chelonia the pubis is much larger than the ischium, which bone, as well as the ilium, is small, the ischium being a simple flattened dicebox-shaped bone.

The femur has much the proportion seen in the Sea-otter (*Enhydra*), and is mammal-like in its hemispherical articular head. The great trochanter is rather less developed than in most mammals. The obturator pit is moderate; but, the inner lesser trochanter being prolonged up the bone almost as far as the great trochanter, the proximal end has a character unlike that of any mammal's. The distal end, expanded from side to side, is not more thickened from before backward than in the Walrus and Seal; in those animals, however, the shaft is not cylindrical, and the articulation is deeply divided into two parts.

There is no patella. The tibia in old Testudines is a massive bone, with almost the heavy proportions of the tibia in a Rhinoceros. It wants, however, the cnemial crest, of which all mammals have some indication at the proximal end in front. In the form of the distal end it approximates to that of mammals, being intermediate between that in the Kangaroo and the usual placental type. The proximal end is not expanded so much from front to back as in most mammals; but the articulation has two ill-defined facets for the femur.

The fibula is relatively stronger than in the Rhinoceros, and differs from most mammals' in its cylindrical shaft, and in articulating proximally with the femur. Distally it articulates with the os calcis, as in Marsupials and, it may be, some Carnivores.

The tarsus consists, as in mammals, of two rows of bones, but wants the naviculare, and differs, moreover, in having the astragalus and os calcis anchylosed together side by side, so that neither bone has the characteristic mammalian characters.

In the Testudine hind foot there are four digits. The metacarpals are short, obliquely overlap each other at their proximal ends, and are expanded from side to side distally, shorter and stronger

bones than are usual with mammals. The claw-phalanges are proportionally longer than in *Orycteropus*; but in that animal they are compressed from side to side, and not from above downward.

§ 2. *The Avian Characters of Chelonians.*

There is no resemblance between the Avian and Chelonian crania, except in the immaterial point that both are toothless, and both, in an immature condition, have members which show transitional indications of teeth. In the lower jaw both have the dentary bone similarly single [typically]. And the number of elements in the lower jaw is seemingly often the same, though, from the obliteration of sutures in birds, the number of bones is not always easily determined in the mature animal.

In the marine Chelonia the length of the neck-vertebræ is like that in the Penguin. In *Testudo* there is an approximation, both in length and in form, to the anterior vertebræ of long-necked birds, such as the Heron or Swan; but the bird never has the centrum so free from lateral processes as *Testudo*, never has the zygapophyses prolonged so far forward, and never departs in the neck from the Avian articulation. The dorsal region of Chelonians is so much modified in relation to the immovable carapace that detailed comparison is impossible. It may be noticed that the underside of the dorsal centrum is often smooth and rounded as in such birds as the Heron.

The sacrum has nothing in common. The tail is similar in such birds as the Swan and in *Testudo*, correspondence being seen in the short centrum flat on the underside, the depressed neural arch devoid of neural spine, in the transverse process coming off from the base of the centrum. In place of the chevron bones seen in some freshwater Chelonians, birds rarely have more than a mere ossicle between the vertebræ, approximating to the intervertebral ossicle of Lizards, or a few vertebræ have long double hypapophyses after the manner of Serpents.

The form of the Chelonian pectoral arch, consisting of scapula and coracoid, is closely paralleled by Struthious birds. The elongated coracoid in the young bird is about intermediate in length between that of the marine and land types; but in Chelonians the bones have no distal articular surface, not meeting any sternum. The scapula in Chelonians is straighter and more cylindrical; it gives off near the articulation with the coracoid a digital process which Mr. Parker names the precoracoid, and which in

Struthious birds is an ossified prolongation of the scapula along the side of the coracoid. In old age this element in the bird unites again with the distal end of the coracoid so as to enclose a foramen.

The sternum and clavicle of ordinary birds are not to be compared with those of the Chelonia.

The testudine humerus is massive and stout, as in Parrots, from which that of *Testudo* differs chiefly in being more curved, in having the head hemispherical, and in having the ulnar process prolonged beyond the articulation instead of being reflected over on the posterior side of the bone as in Lizards. In the Ostrich the radial crest of the humerus is suppressed. At the distal end of the bone birds have the condyles much more developed than Chelonians, and in this respect are more Lizard-like; so that distally the resemblance is better in the Ostrich than in other birds.

The proportions of the ulna and radius of Chelonians are perhaps best matched in the Penguins, in which, however, the bones are even more compressed. As in birds, the ulna is the larger bone; but the majority of birds differ in having it cylindrical and long. Both bones are best paralleled in the Ostrich; and the comparison is better made with a middle-aged *Testudo* than with an old animal.

The carpus, metacarpus, and phalanges are incomparable.

The dorsal ribs are comparable in that the epipleuron in such birds as the Parrot grows so as to cover the interspace between the ribs, and so shows a faint approximation to the condition of the same element in the young Chelonian, though in the bird the epipleural parts overlap instead of abutting one against the other.

The pelvis has no common character in birds and Chelonians.

The femur is similar to that of a bird, but differs chiefly in the proximal end being twisted at right angles with the distal end, the twist being more perfect than in many mammals, while the proximal articulation is smaller in birds, and a sharp ridge runs from the great trochanter some distance down the front of the bone. The distal end in birds is thicker from front to back, and has the condyles much better defined. In its proportions the femur might be compared to that of the Ostrich and many carinate birds.

Birds often have a patella, which Chelonians have not.

The fibula of the bird is unlike the Chelonian's in having no distal end; but the proximal end similarly articulates with a facet on the outside of the femur. The tibia of the bird would only approximate to that of the Chelonian before its proximal and distal epiphyses were anchylosed. As it is, there is no close resemblance; and no resemblance at all is found in the tarsus, metatarsus, and phalanges.

§ 3. *The Crocodilian Characters of Chelonians.*

[See also the Chelonian characters of Crocodiles, p. 172.]

These characters, properly so called, may in the cranium be regarded as the growing together of the squamosal, parietal, and postfrontal bones, which in the Crocodilia leave only a small temporal fossa between them, while in the marine Chelonia the growth has extended till the foramen is obliterated. Similarly there may be supposed in Crocodiles a tendency of the squamosal and postfrontal bones to grow down to meet the quadrato-jugal and malar, which growth is seen perfected in *Chelone*, though the quadrato-jugal bone is vertical. On the other hand, by enlarging the temporal fossa in the Crocodile so as to divide the postfrontal from the squamosal bone (towards which there may be supposed a tendency in Crocodiles with the temporal fossa largest, such as the great Gavial), the postorbital features of the Crocodilian head would approximate towards the Testudinata. In the vertebral column there is no character which can be considered to be Crocodilian, the long tail and chevron bones of *Emysaura* being associated with an opisthocœlous centrum, which hitherto has not been found in a Crocodile: though occurring in the tail and neck, it may be considered eminently Chelonian, and is probably only obscured in the back by the formation of the carapace.

What the pectoral arch would have been but for the peculiar envelope of the Chelonian it is difficult to judge; but as it stands, no Crocodilian characters can be recognized. The only Crocodilian feature of the humerus is the radial crest, which it shares with birds, the Chameleon, and a few mammals.

The elongation of the proximal carpal bones under the ulna in *Chelone* is paralleled in Crocodiles. And the elongation of the metacarpals and phalanges of Crocodiles is better matched in the marine than the land Chelonia.

In the pelvis the shortness of the ilium in marine Chelonia is a character which is approximately Crocodilian, but it is rather like a less distant removal than a mark of affinity: the form of the ischium, too, is least dissimilar in marine Chelonians.

The approximation of the tibia in *Emysaura* and *Chelone* to the triangular form is Crocodilian.

There is a general resemblance in the character of the articular surfaces at the joints, and in the absence of epiphyses; but in the Chelonia the sharpness of definition increases considerably with old age, probably more than in Crocodiles.

§ 4. *Lacertian Characters of Chelonians.*

I do not recognize in the head any community of character beyond such generalities as the vertical orbits in *Iguana* with temporal fossæ behind them.

The pelvis is comparable both in the arrangement of the bones and in their form. The ilium, however, is attached to the sacrum by the middle of its inner surface, and not by its free end as in Chelonians. As in *Emysaura*, the Lacertian pubes and ischia do not meet each other mesially so as to define obturator foramina. The os pubis of Lizards differs chiefly in being perforated by the obturator nerve, and in having the anterior digital process connected by intervening bone with the anterior margin, so as to make the form of the pubis roughly triangular, and not triradiate as in *Testudo*. The ischium is like that in *Emysaura*; so that when the two bones meet mesially their ventral margins form a Y-shape in *Iguana*, the cleft part being behind.

The resemblance does not cease with the hind limbs, though they are usually larger than the fore limbs in Lizards, while in Chelonians the inequality is much less marked, and only with Emydians are the hind limbs visibly the longer.

To make the femur of *Emysaura* comparable to that of *Iguana*, it would only require that the bone should be straightened, and that the trochanter on the fibular side (the great trochanter of mammals) be entirely suppressed.

There is a general resemblance of proportion and form between the subtriangular tibia and fibula. The latter bone is usually more slender. The comparison is best made between the Nilotic *Monitor* and *Emysaura serpentina*.

The proximal tarsals with the bones anchylosed into one row

are so similar in *Iguana* and *Emysaura* that they might be easily confounded. The distal tarsal bones of Lizards differ in being limited to two. The metatarsals and phalanges of Lizards differ in being elongated, but approximate best to *Emysaura* and the marine Chelonia, which latter similarly have five digits.

§ 5. *The Chameleon-characters of Chelonians.*

The Chameleon-characters are few. In the head they are seen in the backward prolongation of the supraoccipital and parietal bones, coupled with the high form of the cranium. The premaxillaries are similarly narrow in front; but they do not enter into the lateral perforation of the anterior nares, but into the superior membrane-covered vacuity which I have already spoken of as the middle hole of the skull.

The palatine bone appears similarly to form the inner floor of the orbit. It may be worth consideration whether the Chelonian terminal hole in the head does not represent the middle hole rather than the true nares, and whether by the prolongation forward of the prefronto-nasal, maxillary, and premaxillary bones, nares in front of these might not be circumscribed which should be more analogous to the nares of *Chamæleon*—a view which is not unsupported by the existence of long fleshy snouts in some Trionychidæ.

The elongated scapula of the Chameleon approximates to that of the Tortoise; but the resemblance would seem to be accidental.

§ 6. *The Rhynchocephalian Characters of Chelonians.*

The Rhynchocephalian palate has only a resemblance of form to the Chelonian; for the maxillary and premaxillary only margin it, there is no similar aperture for the posterior nares, and, although the palatines are parted from each other as in many Chelonians, it is by the pterygoid bones and not by the vomer, which bone is here double and makes the anterior part of the palate. The basioccipital and basisphenoid are exhibited on the underside of the head; but in the adult they form one bone. The pterygoid gives off a strong lateral process into the lateral pterygoid fossa, as in *Podocnemis*; and the bones diverge against the basisphenoid to reach the quadrate, as in *Chelone midas*; but there the resemblance ends.

The oblique orbit is surrounded by much the same bones as in a

Chelonian, the maxillary and malar below, the postfrontal and quadrate behind, though in *Testudo* the bone which represents the quadrato-jugal, while penetrating the suture between the postfrontal and malar, does not reach the orbit; above are the postfrontal, frontal, and prefrontal, the latter bone in Chelonians rarely being distinct; and in front is a small lachrymal, which is not found in Chelonians.

The nostril differs from that of a Chelonian in having the premaxillaries prolonged upwards to be embraced by the front of the nasal bones.

There is a resemblance to Chelonians in the median bones of the roof of the skull all being double.

The quadrate bone is vertical in *Hatteria*, and suturally wedged in the skull; but it has a form of its own and a peculiar antero-posterior perforation; and the back of the skull has little in common with Chelonians.

The pelvis is very like that of *Emysaura*, and in old animals would probably approach near to *Testudo*.

The ischium has the Chelonian shape, with a not dissimilar posterior tuberosity; it is, however, united to the pubis only by a strip of cartilage as in *Iguana*. The pubes have between them a diamond-shaped cartilage in front, which, fully ossified, would give the pubic bones a form like that of the old *Testudo*. The bones are perforated, as in Lizards, by the obturator nerve. The ilium inclines a little backward, is flattened, has the sides subparallel, but, as in Lizards, extends beyond the point of attachment to the sacrum.

§ 7. *The Serpent-characters of Chelonians.*

In the Boa there is a similar prolongation of the parietal and occipital bones backward into a crest and spine. The maxillary bone is similarly introduced into the base of the orbit; and, as in *Testudo*, the posterior boundary is made by the postfrontal bone, the upper boundary by the frontal, and the front boundary by the prefrontal. In the Boa and in the poisonous group the small premaxillary is similarly toothless. And though the anterior nares are double in Serpents, they are bordered by the nasal, maxillary, and premaxillary bones as in Chelonians.

The method of articulation in the vertebral column, and the double hypapophysis in the tail preclude further comparison.

§ 8. *The Urodelan Characters of Chelonians.*

There is a general resemblance of form between the crania of *Chelys mammata* and the Menopome. The quadrate and squamosal bones are as firmly fixed in the skull as in Chelonians, and in the Mammata are similarly directed more outward than downward. The maxillary and prefrontal make the front and base of the orbit; in Salamanders its hinder part is not circumscribed with bone. The pterygoid in the Menopome is a large bone like that of the Mammata, and the bones are mesially parted from each other as in *Trionyx*; only the separation is made by the basitemporal in the Menopome, and not by the basisphenoid. The pterygoid in both similarly meets the quadrate. In Tritons the quadrate bone is directed forward as in the extinct Ornithosauria.

The humerus of the German Salamander has a digital process at the proximal end, which is not likely to recall the ulnar process in a Chelonian. The radius is proportionally a very large bone, and is greatly expanded at the distal end. The ulna is sufficiently similar to that of marine and freshwater Chelonia to suggest comparison.

The carpals in *Menopoma* have no existence; in the Salamander they are well ossified, and, though very different, are more suggestive of the marine Chelonia than of the other types.

The pubis is unossified in the Urodela; and the ischia are large reniform bones unlike those of any Chelonian; but the ilium appears to be similar.

The femur, though having a hemispherical proximal articulation and a widened distal end, has proximally a digital trochanter unlike that of a Chelonian and more suggestive of an Iguanodont Dinosaur's.

The tarsals differ in the same way as the carpals; and the compressed dicebox-shaped metacarpals and phalanges are intermediate in elongation between the marine and land types of Chelonians.

Usually Batrachian bones differ from those of Chelonians in being hollow, and in having epiphyses.

PART III.

THE SIMILITUDES OF LIZARD BONES.

§ 1. *The Mammalian Characters of Lizards.*

The nearest approximation to the diverging V-shaped parietal crest of Lizards is the faint V-crest of certain Seals, like the Grey Seal. The few mammals which have the external nostrils double never have the division made by the nasal and premaxillary bones meeting mesially, but by a jutting forward of the ethmoid. The maxillary bone is similarly excluded in Ruminants and Pachyderms from a circumscribed orbit, by development of the malar and lachrymal bones.

A change in the forms of the teeth, like that of many Lizards, is seen in many mammals in the transition of incisors to canine, and to premolars and molars; only the molar teeth of Lizards never have a divided fang.

The ribless neck-vertebræ in the Monitor are six; in other Lizards there are usually fewer. Oxen have a strong neural spine and a well-developed hypapophysis; but neither is relatively ever so long as in the Monitor; and mammals never have a long intervertebral ossicle as in *Iguana*, or a procœlous cup-and-ball articulation; in many of the long-necked mammals the transverse process is as little developed as in Lizards. The axis of *Iguana*, with its large forward-reaching neural spine, and large odontoid process placed immediately under the neural canal, might well be compared to a mammal's. In long-necked mammals like the Giraffe there is a similar obliquity in the articulation in the centrum, its upper part leaning forward.

The dorsal vertebræ agree with those of all mammals except Cetaceans in not having the ribs supported on transverse processes, though a few early vertebræ in the Dragon have a short massive lateral process to which the large head of the rib articulates. They resemble *Myrmecophaga* and Cetacea in having the rib attached only to its own proper vertebra. They resemble true Whales in the articulation being strictly single, but differ in the expanded cup-shaped articular head, which is sometimes vertical. This single-headed condition is seen in the hinder ribs of many mammals and in *Ornithorhynchus*.

The dorsal region has the visceral surface of the centrum

generally rounded and smooth. The neural arch in the early part of the back is usually directed forward in mammals, as it is in the back of *Iguana*; and in the lumbar region of mammals the neural spine is usually quadrate and erect as in the back of *Monitor*.

The tail in long-tailed mammals like the Marsupials and Monotremes rarely includes more than twenty vertebræ, except in *Paradoxurus*, while in *Monitor* there may be more than 100. The transverse process is more persistently developed in the mammalian caudal region than in Lizards; in Lizards the neural arch is the persistent part.

The ribs of Lizards appear to consist of a variable number of parts determined by the state of the specimen as fresh or dry. Taking three as the normal number in *Iguana*, the same number of parts may be seen in a few ribs of some Porpoises; and in *Ornithorhynchus* there is a long unossified element between the dorsal and sternal ribs.

The pectoral girdle resembles that of a Monotreme in consisting of scapula, coracoid, clavicle and interclavicle, while the mammal differs in the coracoids not meeting the sternum, and in those bones being divided by two others not seen in Lizards, which are named the epicoracoids. The episternum or interclavicle is a T-shaped bone in both, which carries the clavicles [often] on its cross bar in front, and in the mammal meets the proximal end of the sternum behind, while in the Lizards it extends mesially down the front of the large lozenge-shaped sternum. The ends of the cross bar in some Lizards unite with a process of the coracoid; in the mammal they extend along the clavicle nearly to the acromion process of the scapula. The scapula of the Monotreme, with its anterior lateral acromion-process, situate as in Cetaceans, is like the scapula of *Iguana*, where, however, the process is much longer—though in *Monitor* the coracoid unites with the whole side of the scapula, so that there is no true acromion. In the Monotreme the clavicle extends to this process; in the Lizard it extends beyond it to the suprascapula. The massive coracoid of *Chamæleon* or *Hatteria* is more like that of Monotremes than the emarginate bones of ordinary Lizards.

The diamond-shaped sternum of the Pike-Whale is relatively smaller than in Lizards, and has different relations; and, except in Chameleons, it is not usual for Lacertians to have the sternum

formed of elements placed one behind the other, as in mammals.

The limb-bones with their epiphyses remind us of mammals' and Salamanders', though in the larger bones the resemblance of form is small. Bears, like Lizards, have the ulna larger than the radius: mammals have the bone compressed from side to side as it is in Lizards; but in mammals the proximal end is usually prolonged beyond the articulation. The carpus, metacarpus, and phalanges are very like in form to those of mammals, except that in Lizards the phalangeal bones are more elongated.

There is considerable resemblance in the pelvis to that of a mammal, so that if the pelvis were turned round about the sacrum so that the ilia were directed forward, little would be needed to make the pelvis mammalian, beyond the prolongation mesially backward of the pubes to meet the ischia and so form obturator-foramina, a suppression of the prepubic angle of the pubis, and an expansion of the free end of the ilium.

The femur is unlike that of any mammal in having the inner or tibial trochanter of the proximal end greatly developed, and the outer or great trochanter suppressed—as well as in having the articular head compressed, which is also a feature of the humerus. The inner trochanter of the femur of *Ornithorhynchus* is similar; but the bone in no other respect is like that of Lizards.

There is no patella in Lizards. The tibia differs from most mammals' in being, at the proximal end, compressed from front to back; in *Dasyurus* it is subcylindrical. The fibula differs from mammals' in articulating with the side of the femur. The tarsus is not mammalian; and the other bones of the foot differ from mammals' chiefly in their great length.

§ 2. *The Avian Characters of Lizards.*

The single premaxillary extends between the nares and between the termination of the nasal bones, after the manner of birds; but in birds the lateral rays of the bone diverge backward, and form that part of the palatal border which in Lizards is made by the maxillary bones; and in Struthious birds the premaxillaries make a conspicuous part of the palate.

The free motion of the quadrate bone is avian; but the bone does not articulate with the wall of the brain-case as in birds. The basisphenoid in Struthious birds gives off similar lateral pro-

cesses to articulate with the pterygoid; and the presphenoid is similarly prolonged forward between the pterygoids. These bones, though smaller in the bird and of different form, similarly diverge behind, and unite with the inner sides of the quadrate bones, lapping behind the process which the quadrate of the bird, in common with that of the Rhynchocephalian, sends forward and inward.

There is a general resemblance between the form of the dorsal vertebræ in *Monitor* and in birds, so far as concerns the shape of the neural spine, the length of the centrum, and the concave side-to-side outline of the articulation seen on the under surface; but Lizards, unlike birds, Crocodiles, and Salamanders, have no transverse process, which in the neural arch of birds forms a platform down the back, to which the second head of the rib articulates. The elongation of the neck, the shortness of the tail, and the anchylosis of the sacral vertebræ in birds are unlizardlike.

The pectoral arch of Struthious birds may be compared to that of *Chamæleon*. The sternum is similar, and gives attachment to short broad coracoids, which make the acetabulum for the humerus, with an elongated unexpanded scapula.

Carinate birds have the clavicles as well developed as in ordinary Lizards; and then, as in Monotremes, they similarly articulate with the small acromial process of the scapula, but do not reach beyond it as in Lizards. In the Penguin the scapula is almost as much expanded as in Lizards; but the acromion is short and not given off from the middle of the front margin, but from near the union of the bone with the coracoid. If the keel of the bird's sternum represents the interclavicle of Lizards, it is not often that it preserves, as it does in the Shrike, the transverse bar of the T-shape; the interclavicle of *Iguana* has an incipient keel; and, in general, the interclavicle of the bird may be supposed to be formed, like that of the Skink, in a +, if it exists at all.

The ribs of true Lizards never show the epipleura characteristic of birds, which are well developed in *Hatteria*; nor do the ribs usually consist of so few as two elements, though often as many sternal ribs articulate with the sternum in Lizards as in birds.

The humerus corresponds closely with that of carinate birds, and from the Parrot differs chiefly in not having the radial crest so much compressed, in not having the ulnar process excavated for a pneumatic foramen, and in having the distal end more expanded from side to side.

The ulna and radius rather resemble those of Struthious than carinate birds, since carinate birds have not the proximal end of the ulna so large, or the whole bone so much compressed, and they usually have the distal end impressed mesially so as to make the articulation pulley-shaped. In Struthious birds, too, the distal end of the bone is more expanded from side to side. The radius corresponds with the Ostrich better in proportion than in the form of the articular ends.

The resemblances in the remainder of the skeleton are very slight. Even the femur, though similar in proportion, differs in wanting the external trochanter, and in having an internal trochanter (which in birds is not developed), in having the proximal articulation large and terminal instead of at right angles with the shaft as in birds, and in having the condyles of the distal end less divided in those few Lizards which, like the Monitor, show indications of a dividing groove.

The phalanges are often similar, and the claws are compressed from side to side.

§ 3. *The Crocodilian Characters of Lizards.*

Uromastix and *Iguana* are Crocodilian in having the frontal and parietal bones single and the nasals double. The frontal bone similarly divides the orbits. The downward direction of a process of the pterygoid and of the transverse bone, so that they fall within the lower jaw, is Crocodilian.

Those Lizards (like the white Skink) which after the first two vertebræ have cervical ribs, never have them of the ⊥-shape with double heads which characterizes Crocodiles.

Only in the earlier dorsal vertebræ of the Dragon are there short transverse processes to the vertebræ; but they are given off from the centrum, and are never notched for ribs after the manner of Crocodiles, but are single-headed and shorter and stronger. In the tails of many Lizards, however, the transverse processes are even more developed than in the Crocodile, especially in *Uromastix*; and in Lizards the vertebræ are more numerous. They usually have the articulation of the centrum oblique, while in Crocodiles it is vertical; and in Crocodiles the centrum is more compressed from side to side. In the young Crocodile the articular faces of the caudal centrum are flat or slightly convex as in mammals, and so far unlike Lizards'.

The pectoral arch of the Crocodile differs from that of true

Lizards in wanting an episternum and clavicles, as well as in the forms of the coracoids and the scapulæ. The shapes of the pectoral bones are points in which the different Lizards differ greatly among themselves—the Skink having the episternum +-shaped, with expanded clavicles. In *Monitor* the scapula adjoins the coracoid along its whole length; in *Uromastix* the scapula has no acromion process; in *Stellio* the clavicles are brought down to the anterior margin of the sternum; and in the Dragon the scapula is like that of the Crocodile.

The humerus similarly has a compressed proximal articulation; but the bone in Lizards puts on many other characters not seen in Crocodiles, such as the twist in the bone, the widening of the distal end, the development of the distal condyles, the thickening of the radial crest, and the formation of an ulnar tuberosity. With a general resemblance, the ulna has scarcely a Crocodilian character beyond a compression of the bone from side to side; for though the inner outline of the bone in Lizards is concave, its outer outline is straight, and not convex as in Crocodiles, so that the proximal end of the bone in Lizards becomes more massive, is more prolonged on the outer side, and a concave articulation is made in it for the humerus.

The radius has a straight Crocodilian cylindrical shaft, but develops characters of its own in the concave proximal end, and in the process of the distal articulation, which, like that of the mammalian tibia, is directed inward.

The carpus is very unlike; but the metacarpals and phalanges differ but little.

There are no Crocodilian characters in the pelvis.

The Lizard femur is less unlike the Crocodile than the humerus, being similar in proportion, and having a similarly compressed articular head; but while in Crocodiles the articular head is so directed as to give a convex outline to the hinder side of the proximal end of the bone, in Lizards the corresponding surface is concave; and the tuberosity, which on the inner side of the shaft in Crocodiles is scarcely a prominence, in Lizards becomes the large inner trochanter, which is especially prominent in Skinks, and but slightly prominent in the Dragon.

There is much resemblance in the proportions of the tibia and the fibula: but in Lizards the distal end of the tibia sends a process downward and inward as in mammals, and the proximal end of the bone is compressed on the inside; in Lizards the fibula is

more compressed from side to side at the distal end, and its proximal end usually curves backward.

There are many points of difference in detail (in the metatarsals and phalanges), but nothing inconsistent with both having had a primitive plan in common.

§ 4. *The Chelonian Characters of Lizards.*

There is no community of character in the skull, or vertebral column, or pectoral girdle, beyond such features as all reptiles have in common.

In the humerus of *Emysaura*, however, are found all the points of the lacertian humerus; only they are exaggerated to an extent which might be considered grotesque.

In the os pubis of *Uromastix* and the Dragon the prepubic angle is prolonged into a digital process similar to that of a Chelonian. The ischium of *Emysaura* is similar to that of *Iguana*. But there seems to be in the ilium of Lizards always an angular process in front above the acetabulum, of which Chelonians give no indication.

The characters of the Lizard femur, like those of the humerus, are burlesqued by *Emysaura*; and a new character is added by the development of a great trochanter.

The tibia and fibula would correspond very well with *Emysaura* but for the greater stoutness of the bones in the Chelonian.

The tarsus corresponds generally; and the bones of the Emydian digits may be matched by those of the White Skink.

§ 5. *The Serpent-characters of Lizards.*

The parietal in *Iguana* sometimes has a median ridge approximating to that of *Python*. The squamosals in Serpents are always prolonged backward; but in Lizards the parietals are prolonged with them and over them. The nares of both are divided by a single premaxillary. The orbits are similarly vertical. The pterygoid bones are very similar in their forms and in their connexions with the quadrate, transverse, basisphenoid, and palatine bones; and in *Iguana* they are similarly divided from each other mesially. The palatine bones of Serpents, like those of *Hatteria*, carry teeth, and similarly abut against the maxillary, and similarly are divided by the vomer; but in the Boa the palatine is a narrow bone

The vertebral column of Serpents resembles that of *Iguana* in the form of articulation of the neural arch by addition of a zygosphene; but the *Iguana* has the neural spine inclined backward and thickened posteriorly, which is not the case in Serpents; also in transverse section the part of the arch at the base of the neural spine which is convex in Serpents, in Lizards is concave. The articulation for the rib is more elongated vertically in Serpents than is usual in Lizards.

§ 6. *The Urodelan Characters of Lizards.*

As in Rhynchocephalia and Ophidia the palatine abuts against the maxillary and carries a second row of teeth, the pterygoid and palatine are more expanded than in Lizards (in this rather recalling *Chamæleon*), and, with the parasphenoid between the pterygoids, in the Hell-bender, make a closed palate.

The nasal sacs are double, and in the Hell-bender appear to be surrounded by a similar set of bones to those which margin the anterior nares in *Monitor*.

As in *Monitor*, the Hell-bender does not prolong the maxillary arch backward, and the orbit has no margin of bones behind; the animal is unlike *Monitor* in having all the median roof-bones of the skull double.

Supraoccipital and basioccipital in the Hell-bender would seem not to exist, though the posterior part of the basitemporal looks as though it might well become a basioccipital bone like that of mammals.

The atlas of the Hell-bender has a strong resemblance to the axis of mammals and Lizards, what would be called the odontoid process fitting into the vacuity where the basioccipital is usually found, while the flattened lateral facets of the centrum fit on to the exoccipital bones. And this would raise the question whether if a vertebra with the characters of an ordinary atlas came to be developed between this vertebra and the skull, its centrum would not go to form a basioccipital bone. The outline of a vertebra in Hell-bender is very similar to that in Skink, differing in more perfect suppression of the neural spine, and in the development of transverse processes from the centrum, which in many Salamanders are double-headed. These processes are long in the Hell-bender; in *Triton* they are short, and give attachment to double-headed ribs, which have in the middle of their hinder margin an epipleural element, also seen in the earlier ribs of the

German Salamander. The transverse processes are directed backward; and the chevron bones of the tail are anchylosed to the centrum.

The scapula and coracoid are the only elements of the pectoral girdle ossified in Salamanders; the coracoids are widely divided by cartilage. There is a general correspondence of this part of the pectoral arch to that of Skink, except that the acromion in Salamander is a very wide short process which unites along its length with the coracoid. The latter bone has much the form seen in *Hatteria*.

The humerus and femur are both distinguished by the curious digital trochanters of their proximal ends. With regard to the other bones, along with a general resemblance of form, which from the absence of epiphyses cannot be traced in the articulations, there is a greater tendency in the bones to enlarge at the distal end than is the case with Lizards.

The ilium has the Lizard-direction upward and backward; but, as in Chelonians, it does not extend beyond its transverse process.

PART IV.

THE SIMILITUDES OF SERPENTS' BONES.

The absence of limbs and pectoral and pelvic arches limits comparisons to the head and vertebral column, which latter is so unlike what is characteristic of other types that the similitudes of Serpents' bones are necessarily few. Little in common with mammals will be noticed beyond the large development of the parietal and frontal bones, and the parietal crest seen in the Boa and Python, of which an analogue may be noticed in *Dasyurus*, *Thylacinus*, and the Spotted Hyæna. An analogous form of the neural arch, but with the zygapophysial characters which are anterior in Serpents developed at the posterior end of the arch, occurs in the lumbar vertebræ of Armadillos and *Myrmecophaga*; but the centrum in those animals is unlike that of a serpent's vertebra.

The resemblances to the bird are chiefly in the large share which the parietals take in covering the brain, and in the function of the frontals in completing the covering in front, in the basisphe-

noid having articular facets for the pterygoid bones, as in Lizards, and in the similar prolongation of the presphenoid bone forward. The pterygoid bones, as well as the palatines, are similarly divided from each other mesially: in birds, however, they are toothless and small, and have attachments only with the quadrate, palatine, and presphenoid. The quadrate bone is free in Serpents, but of of more typically lacertian than avian form; and in birds the squamosal bone enters into the wall of the brain-case, while in Serpents it has not even osseous union with the brain-case, though more closely applied to it than is the case with the bone in Lizards.

There appear to be no Crocodilian characters beyond those enumerated already, p. 174.

The Chelonian characters are chiefly those mentioned on p. 184.

The Lizard-characters of the vertebral column and palate are chiefly given on p. 192.

The Urodelan characters are some points in the head, such as the suppression of alisphenoids and orbitosphenoid bones.

I made the foregoing comparisons many years ago for my own use as a basis for other researches, and now offer them as a contribution in aid of a better understanding of the term osteological affinity in the reptilian ordinal groups, in the hope that they form a *Catalogue Raisonné* of the more obvious osseous resemblances and points of supposed affinity, to which comparative anatomists, dealing with new animals or with questions of genetic relation, may have need to refer. And if, by indicating the marked broad resemblances between a few organic types, naturalists should find their toil lightened when pondering the causes of these similitudes and of the more familiar structural differences with which they are coupled—by here seeing at a glance animals in which the resemblances are found,—I venture to suggest that perhaps a similar synthetic examination of the animal kingdom may furnish data for a morphological demonstration of the method of organic evolution, and for that more definite knowledge of the nature of the relations between one group of animals and another which the classifications of the future will aspire to express.